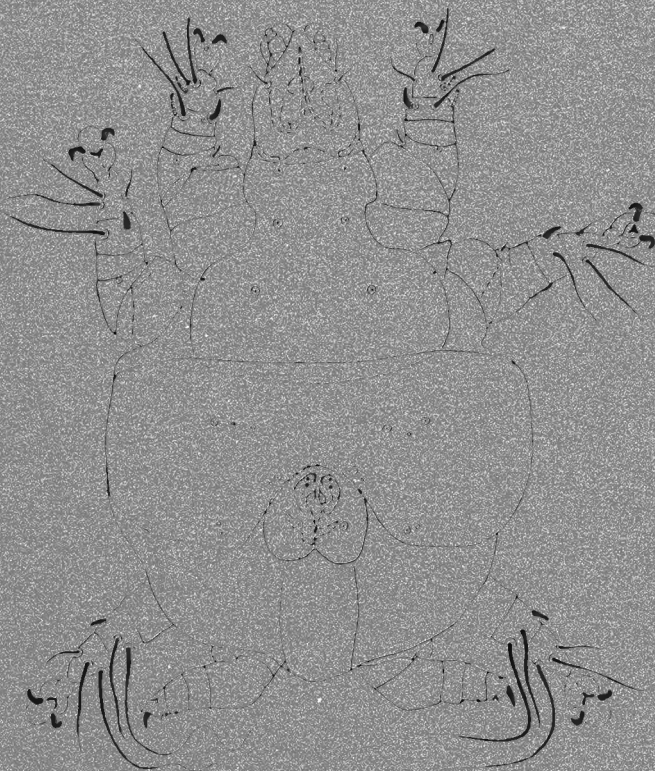


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Cover: *Parobia alipilus* Seeman & Nahrung (Podapolipidae) is one of three sexually-transmitted mites that infest the eucalyptus leaf beetle *Paropsis atomaria*. The adult male (pictured) is unlike the female: his legs have spurs, the genital capsule is mid-dorsal and the fourth pair of legs is modified. Nevertheless, *Parobia* species are among the most mite-like of the Podapolipidae, where physogastry and loss of legs is common and some males have their genitalia on prongs above their heads. *Parobia* mites are often more common on female beetles and at least one species significantly reduces survival of the host during overwintering. Illustration by Owen Seeman.

PHYLOGENY OF THE TROIDINE BUTTERFLIES (LEPIDOPTERA: PAPILIONIDAE) REVISITED: ARE THE RED-BODIED SWALLOWTAILS MONOPHYLETIC?

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Abstract

The phylogenetic relationships and biogeography of troidine butterflies are reassessed. The subtribe Troidina is considered to comprise the following generic groups, representing vicariant separation within western, central and eastern Gondwana respectively: *Parides* Hübner + *Euryades* C. & R. Felder; the 'red-bodied swallowtails' *Atrophaneura* Reakirt + (*Pachliopta* Reakirt + (*Losaria* Moore, stat. rev. + *Cressida* Swainson)); and the 'birdwings' *Trogonoptera* Rippon + (*Troides* Hübner + *Ornithoptera* Boisduval). *Pharmacophagus* Haase, with its sole species *P. antenor* (Drury) from Madagascar, is retained as a subgenus of *Pachliopta*. The suggestion that *Pharmacophagus*, *Cressida* and *Euryades* are relict taxa is rejected.

Introduction

Recent studies on the phylogeny and biogeography of troidine butterflies have shown little agreement. For example, Hancock (1983, 1988), Miller (1987) and Parsons (1996a, b) produced classifications which differed markedly, particularly with regard to the placement of *Atrophaneura* Reakirt and its allies. Until now, it has not been possible to reconcile these differences. However, a recent study by Braby *et al.* (2005) has strongly suggested that almost all previous phylogenies were based on a misconception - that *Cressida* Swainson and *Euryades* C. & R. Felder were sister genera. The suggestion by Braby *et al.* (2005) that this is not the case enables several morphological characters, previously considered to be homoplasious (*e.g.* the distinctive red abdomen seen in several genera, including *Cressida*), to be reassessed and seen as potential synapomorphies.

Morphological relationships

Monophyly of the tribe Troidini and subtribes Battina and Troidina has been recognised by most recent authors (*e.g.* Hancock 1983, Miller 1987, Braby *et al.* 2005) and appears well established. Subtribe Battina contains the sole genus *Battus* Scopoli, known only from North and South America. It is of either North American (Hancock 1983) or Gondwanan (Braby *et al.* 2005) origin. Subtribe Troidina contains all the remaining genera in the tribe and is of undoubted Gondwanan origin. Three distinct groups of genera are recognisable on morphological grounds; these appear to be vicariant groups originating in eastern, western and central Gondwana respectively. Genera in this subtribe are united by numerous characters (Hancock 1983, Miller 1987), including the presence of a basal seta on the subdorsal tubercles of the first instar larva (Igarashi 1984) and red hairs on the head and thorax (and often the abdomen) of the adult, a condition not seen elsewhere in the Papilionidae. Larval food plants for the Troidini are all members of the family Aristolochiaceae (*Aristolochia*, *Pararistolochia*, *Thottea* and *Apama*).

***Trogonoptera* Rippon, *Troides* Hübner and *Ornithoptera* Boisduval**

Although disputed by Parsons (1996a, b), monophyly of this group of genera, the 'birdwings', is well established. The relationship *Trogonoptera* + (*Troides* + *Ornithoptera*) was suggested by Hancock (1983, 1991) and supported by Miller (1987, as subordinate groups within *Troides*), Hancock and Orr (1997) and Braby *et al.* (2005). [Note that in Fig. 3 of Braby *et al.* (2005), the names *Troides* and *Troides* (*Ornithoptera*) should be transposed]. The genera are restricted to the Indo-Australian region. They share the following characters: abdomen without red hairs; juxta U-shaped; pseuduncus generally long, apically pointed and with a basal suture (secondarily reduced in *Trogonoptera*); aedeagus short; bursa large with membranous ductus bursae and well developed appendix bursae; signum comprised of concentric folds (all characters similar to those seen in *Battus*). Defining characters were noted by Hancock (1983) and Miller (1987).

***Parides* Hübner and *Euryades* C. & R. Felder**

Although their evidence was not well supported, Braby *et al.* (2005) suggested that these two genera were sister groups. Significantly, they found no evidence of a relationship between *Euryades* and *Cressida*. The genera occur in Central and/or South America and share the following characters: abdomen with red hairs, especially posteroventrally; juxta Y-shaped with narrow anterolateral expansions; pseuduncus long, apically pointed and with a basal suture; aedeagus short; female bursa with membranous ductus bursae and no appendix bursae. Larvae with spinose setae on subdorsal tubercles retained beyond the first instar [absent in other groups and *Battus*] (Parsons 1996a). In *Parides* the valvae are entire, the aedeagus broad, the bursa large and the signum broadly C-shaped and transverse. In *Euryades* the valvae are reduced, the aedeagus narrow, the juxta with long apodemes, the ovipositor lobes melanised, the bursa small and the signum absent.

***Atrophaneura* Reakirt and allies**

Monophyly of this group has not been recognised previously. Four Indo-Australian genera and one Madagascan subgenus are included. All have extensive red hairs and scales on the abdomen, much better developed than in *Parides* and *Euryades*. The female bursa has no appendix bursae and the signum, when present, is neither broadly C-shaped nor formed of concentric folds. The first instar larva has the sclerotised, setose apex of the tubercles rounded and dome-like [pinnacle or pagoda-like in other groups] and the pupa has the head short and truncate in lateral view [distinctly produced anterolaterally in other groups and *Battus*] (Igarashi 1984, Parsons 1996a).

Atrophaneura

This is an eastern and southeast Asian genus of some 27 species referred to the *latreillei* and *nox* groups by Hancock (1980, 1988). Miller (1987) regarded these two groups as subgenera included in an unresolved trichotomy

with *Parides*. It differs from other genera in the group by the retention of a well developed scent organ on the male hind wing, a distinct, apically pointed pseuduncus with a basal suture, a short, broad aedeagus, and a large bursa with membranous ductus bursae. The juxta appears to be a modification of the Y-shape, while the signum is longitudinal, expanded anteriorly and narrowly tapered posteriorly. On the hind wing the tail is broadly spatulate (*latreillei* group) or absent (*nox* group) and white areas, when present, at most weakly enter the discal cell. The valvae are entire or weakly emarginate. Larva with a distinct supraspiracular tubercle on first abdominal segment and pupa with distinct, apically pointed subdorsal projections on abdominal segments 2-10 and a broad lateral flange on segment 4 (Igarashi 1984).

Losaria Moore, *Cressida* Swainson and *Pachliopta* Reakirt

These genera differ from *Atrophaneura* in the reduction of the scent organ and shortened vein 1A+2A on the hind wing, elongate and narrow aedeagus, and sclerotised posterior part of the ductus bursae [not evident in *Cressida*]. They occur primarily in the Indo-Australian region, with a single species in Madagascar. The tegumen and socii are frequently enlarged and the valvae are usually reduced. Larva with supraspiracular tubercle on first abdominal segment usually absent and pupa with apically rounded or truncate subdorsal projections on abdominal segments 4-7 (and very weakly on segment 8) and with lateral flange on segment 4 present or absent.

Losaria

This is a Southeast Asian genus of four species referred to the *coon* group by Hancock (1983, 1988). An affinity with *Pachliopta* was recognised by Igarashi (1984), Hancock (1988) and Miller (1987), who placed it either as a subgenus of the latter (Miller 1987) or as a synonym of it. Because of its apparent sister-group relationship with *Cressida*, it is here raised to generic status (stat. rev.), characterised by the elongate forewing discal cell, deeply indented margin to cell Cu of the male hind wing, strongly petiolate and club-shaped tail, posteriorly downcurved abdomen, Y-shaped juxta with broad anterolateral expansions, often reduced but apically acute pseuduncus with a basal suture, reduced valvae, and large bursa with a small, round signum. A sphragis is present in one species and in two the 'red' abdominal markings are yellow. When the hind wing has a white area that crosses the discal cell, the apex of the cell is black. Larva with supraspiracular tubercle on first abdominal segment absent (Igarashi 1984) and subdorsal tubercles on abdominal segments 2 and 3 conspicuously reduced (Weintraub 1995). Pupa with subdorsal projections large and lateral flange present (Igarashi 1984).

Cressida

This is a monotypic Australian genus previously placed with *Euryades*. It differs from related genera in the absence of a tail, large precostal hindwing cell, vestigial bursa and lack of a signum. It shares with *Losaria* the elongate forewing discal cell, deeply indented margin to cell Cu of the male hind

wing, black apex of the hindwing discal cell, posteriorly downcurved abdomen, presence of a Y-shaped juxta with broad anterolateral expansions, apically pointed pseuduncus with a basal suture, and similarly reduced valvae. With both *Euryades* and *L. palu* (Martin) it shares a well-developed sphragis but these appear to be independently acquired and not homologous (Orr 1988, 1995). Larva with supraspiracular tubercle on first abdominal segment absent and all other tubercles reduced; pupa with head truncated in lateral view, subdorsal projections small and lateral flange absent (Igarashi 1984). The male valvae also resemble those of *Euryades* but other characters of *Euryades* [including the socii, pinnacle-like apex of the first instar larval tubercles and anterior projection of the pupal head in lateral view (Miller 1987, Parsons 1996a)] more closely resemble those of *Parides* than those of *Cressida*. The distinctively red abdomen, dome-like apex of the first instar larval tubercles and truncated pupa in *Cressida* provide the best evidence of the affinity of this genus with others in the *Atrophaneura* complex.

Pachliopta

This genus contains 13 species in the Indo-Australian region and one in Madagascar. They were referred to the *polydorus*, *hector* and *anterior* groups by Hancock (1988). The genus is characterised by the spatulate tail [reduced in *P. polydorus* (Linnaeus)], T-shaped juxta, short, blunt pseuduncus with basal suture absent (at least medially), valvae either entire or vestigial, and large bursa with an elongate signum of uniform width. When the hind wing has a white area that crosses the discal cell, the apex of the cell is also white. Larva with subdorsal tubercles not conspicuously reduced. Two subgenera are recognised: *Pachliopta* Reakirt and *Pharmacophagus* Haase. In both the pupa is strongly S-shaped in lateral view and has the lateral flange on abdominal segment 4 present; the anal segments and cremaster, viewed ventrally, are also very similar (Igarashi 1984, Parsons 1996c).

Subgenus *Pachliopta*

This subgenus contains all the Indo-Australian species. Braby *et al.* (2005) noted that *P. hector* (Linnaeus) was more closely related to species in the *polydorus* group than to *P. anterior*, with which it was associated by Hancock (1988). This is supported by the wide separation between tergite 8 and the hypertrophied tegumen and socii, and by the vestigial valvae (see Miller 1987); thus *P. hector* is here subsumed into the *polydorus* group. Larva with the supraspiracular tubercle on the first abdominal segment reduced to a spot in *P. hector* (Woodhouse and Henry 1942), absent in other species (Woodhouse and Henry 1942, Igarashi 1984). Pupa with subdorsal projections large and lateral flange well developed (Igarashi 1984).

Subgenus *Pharmacophagus*

The sole species [*P. anterior* (Drury)] occurs in Madagascar. It differs from subgenus *Pachliopta* in the presence of normal (not vestigial) valvae, a well developed supraspiracular tubercle on the first abdominal segment and

reduced subdorsal tubercles on abdominal segments 3 and 4 of the larva, and small subdorsal projections and lateral flange on the pupa (Parsons 1996a, c). The tail is relatively narrow, similar to that of *P. hector*. Often regarded as a distinct genus, the form of the juxta, pseuduncus and signum, and the presence of blue-green hindwing scales in a rare form of *P. hector* (Woodhouse and Henry 1942), support a close relationship with *Pachliopta*. It was regarded as a subgenus of the latter by Hancock (1993).

Discussion

Pharmacophagus was regarded as a distinct genus by Igarashi (1984), Miller (1987), Parsons (1996a, b, c) and Braby *et al.* (2005). Igarashi (1984) considered it to be 'closely related to *Pachliopta* but highly specialised'. Miller (1987) placed it at the base of the subtribe, *i.e.* as the most primitive genus. However, he identified only one character that unambiguously separated it from *Pachliopta* - the 3-segmented palpi with a 'basal fleck' present. All other genera in the Troidina have 2-segmented palpi [which appear to have formed by fusion of segments 1 and 2: see illustrations in Miller 1987] and no 'basal fleck'. Hancock (1989) suggested that the 3-segmented palpi of *P. antenor* resulted from a secondary loss of this fusion (character reversal) and that the 'basal fleck' was also secondarily acquired, with neither homologous to the condition seen in *Battus*. Its placement as sister genus to *Ornithoptera* (Parsons 1996a, b) was disputed by both Hancock and Orr (1997) and Braby *et al.* (2005) and is not sustainable.

In their molecular study, Braby *et al.* (2005) also regarded *Pharmacophagus* as basal to all other genera in the subtribe. However, only one of the three genes studied (*EF-1a*) supported that arrangement. The *ND5* gene produced a trichotomy of (i) *Pharmacophagus*, (ii) *Cressida*, and (iii) all other genera, whereas the *COI-COII* gene produced an unresolved polytomy of all genera plus *Battus*. Their combined analysis also produced a clade with *Pharmacophagus* at its base, but the placement of *Papilio* Linnaeus as sister to the Parnassiinae in the combined clade, and the placement of the Baroniinae and Parnassiinae between *Graphium* Scopoli and the Troidini (or *Papilio* + Troidini) in all of them, suggest that the use of these genes in resolving higher-level groupings requires considerable caution. Unreliability of the *ND5* gene at higher levels was also noted by Braby *et al.* (2005).

At lower taxonomic levels, recognition of the generic groupings *Parides* + *Euryades*, [*Trogonoptera* +] *Ornithoptera* + *Troides*, and *Atrophaneura* + *Pachliopta* (including *Losaria*) by Braby *et al.* (2005) appears to be well founded, although they were unable to effectively place the seemingly isolated genera *Pharmacophagus* and *Cressida*. Resolution in these cases is best done using morphological characters that, although subject to various interpretations, strongly suggest a sister-group relationship between *Pharmacophagus* and *Pachliopta* in the first case and between *Cressida* and *Losaria* in the other.

An Indo-Australian plus Madagascan pattern of distribution, as shown by subgenera *Pachliopta* and *Pharmacophagus*, also occurs in pitcher plants (*Nepenthes*: *Nepenthaceae*) (Heywood 1978) and the fruit fly genus *Dacus* Fabricius (Diptera: *Tephritidae*), where the largely Indo-Australian subgenus *Neodacus* Perkins is represented in Madagascar by the relatively primitive *xanthaspis* group (Hancock and Drew 2006, White 2006). Furthermore, the largely Indo-Australian butterfly genus *Euploea* Fabricius (*Nymphalidae*) [and which, like *Pachliopta hector*, is known to be migratory] is represented in the Malagasy region by apparently unrelated endemic species in the Mascarenes and Seychelles, but not in Africa or Madagascar (Holloway and Nielsen 1999). Under the above classification, there is no need to invoke an ancient (pre break-up Gondwana) origin for *P. antenor*, which appears to have differentiated much more recently. Its only confirmed food plant, *Aristolochia acuminata* (= *A. indica*; = *A. tagala*) [also utilised by *P. hector*, *P. polydorus* and *P. aristolochiae* (Fabricius)], is widespread throughout the Indo-Australian region (Sands 2002) and is the only *Aristolochia* species known from Madagascar (Parsons 1996c). *Ar. acuminata* is also likely to be a relatively recent arrival from India and there is no evidence that a suitable host existed in Madagascar [or in Africa] prior to its arrival.

The association of *Cressida* with *Losaria* suggests it is not the Gondwanan relict previously believed but a relatively recent arrival to Australia from a Southeast Asian, *Losaria*-like ancestor. As in the case of *Pharmacophagus*, its dispersal as a small founder population into a new environment might have accentuated its genetic differentiation. In both cases, the modified pupa is likely to reflect a need for crypsis rather than an ancestral state. The various specialisations seen in *Euryades* suggest that it, too, is of relatively recent derivation. Sphragis development in *Cressida*, *Euryades* and *Losaria palu* appears to reflect their dispersal into open habitats, as has been demonstrated in the nymphalid genus *Acraea* Fabricius (Orr 1988).

Phylogenetic relationships of the genera and subgenera, as proposed here, are shown in Fig. 1.

Biogeography

Based on the above morphological evidence, the following biogeographical scenario for the subtribe Troidina is proposed. [For dating see Braby *et al.* 2005 and references therein]. During the continental drifting phase following the break-up of Gondwana, the three main lineages within the subtribe Troidina (Fig. 1) appear to have been confined to the Southeast Asian (or Australian), South American and Greater Indian plates respectively. Assuming Africa had already separated, this dates the fragmentation of the ancestral population at *ca* 90-80 Mya [84-80 Mya if Madagascar is also excluded]. The present restriction of both *Parides* and *Euryades* to Central and/or South America strongly supports the suggestion that these two genera now represent the western lineage of the original Gondwanan ancestor.

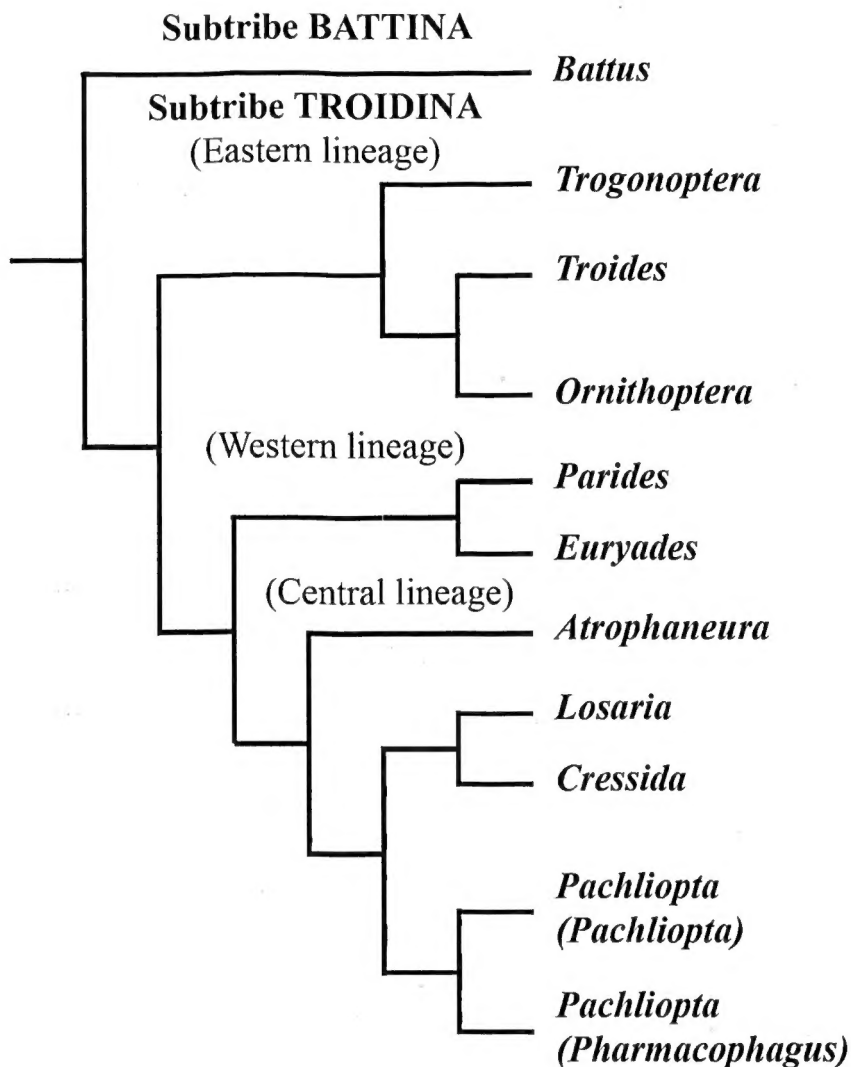


Fig. 1. Suggested phylogenetic relationships of the genera and subgenera of tribe Troidini. See text for discussion of defining character states.

Similarly, the present distributions of *Trogonoptera*, *Ornithoptera* and *Troides* support the suggestion that they represent the eastern lineage of the Gondwanan ancestor. It remains unclear whether the lineage radiated directly from the Southeast Asian (Sundaland) block (see Hancock 1988) into the Papuan subregion via Wallacea [twice, first as *Ornithoptera* via a Sulawesi *Troides* ancestor similar to *T. hypolitus* (Cramer) then, more recently, as *Troides oblongomaculatus* (Goeze)], or (see Braby *et al.* 2005) from Australia into southeast Asia [*Trogonoptera* and *Troides*, leaving *Ornithoptera* in Australia] and, in the case of *T. oblongomaculatus*, back again [with subsequent extinction of the *Trogonoptera* and *Troides* ancestors in Australia]. The former scenario does not require extinctions and seems the more likely. Based on molecular dating, Braby *et al.* (2005) suggested that the *Ornithoptera-Troides* split occurred around 42 ± 8 Mya but this is doubtful and the split is likely to be significantly younger. The Southeast Asian and Australian plates did not make contact until 25 Mya (Braby *et al.* 2005) and whether suitable host plants reached Australia prior to the break-up of Gondwana, or only after contact with Southeast Asia, is uncertain.

Biogeography of the central lineage, the red-bodied *Atrophaneura* and its allies, is more complex. Due to the reassessment of genera such as *Pharmacophagus*, *Losaria* and *Cressida*, the scenario proposed here differs in some details from those suggested by Hancock (1988) and Braby *et al.* (2005). This lineage appears to have been associated with the Indian plate as it broke free from the rest of Gondwana (*ca* 80 Mya), dispersing into Asia as *Atrophaneura* [with increased pupal projections] once contact with it was possible (50-45 Mya). An ability to utilise *Thottea* and *Apama* as host plants might have assisted this dispersal. The suggestion of an Indian origin is supported by the presence of the relatively unspecialised *latreillei* group in eastern Asia, which subsequently appears to have dispersed into Southeast Asia as the more specialised *nox* group (Hancock 1988).

A second dispersal of the Indian ancestor, now differentiated into a *Pachliopta*-like taxon following major climatic, tectonic and environmental changes within the subcontinent, appears to have brought a *Losaria*-like ancestor into Southeast Asia - Sundaland. This dispersal, and that of the *nox* group, possibly accompanied the southward spread of *Thottea* and *Apama* following contact between the Sundaland block and the rest of Asia. Subsequent dispersal and differentiation has brought *Cressida* to Australia, Timor to Tanimbar Is and southern Papua New Guinea, and *Pachliopta* (*Pharmacophagus*) to Madagascar, leaving *Losaria* in southeast Asia and subgenus *Pachliopta* (as *P. hector*) in India. Dispersal to Madagascar possibly took place via the Laccadive-Maldives-Chagos archipelago during a period of lowered sea level. Unlike the condition in *Losaria* and *Cressida*, none of the distinguishing characters of *Pharmacophagus* appear to be distinctive enough to recognise it at generic level; most are homoplasious.

A second major radiation within subgenus *Pachliopta* then appears to have occurred, dispersing again (as the *polydorus* group minus *P. hector*) to Southeast Asia - Sundaland and leaving *P. hector* in India. In these species the wing pattern appears to mimic that of *Losaria*, supporting the suggestion that they radiated first to southeast Asia and from there back to India and Sri Lanka (twice, first as *P. pandiyana* (Moore) + *P. jophon* (Gray), then more recently as *P. aristolochiae*). Subsequent radiations within southeast Asia appear to have resulted in the differentiation of: (1), *P. mariae* (Semper), *P. polyphontes* (Boisduval) and *P. oreon* (Doherty) + *P. liris* (Godart) in the Philippines, Sulawesi and northern Moluccas, and the Lesser Sunda Islands + Timor and neighbouring islands, respectively; (2), the elongate-tailed and largely allopatric *P. schadenbergi* (Semper), *P. leytenensis* Muruyama [= *phegeus* (Hopffer)], *P. phlegon* (C. & R. Felder) [= *annae* (C. & R. Felder)] and *P. atropos* (Staudinger) in the Philippines; and (3), *P. polydorus* from the Moluccas to Australia and the Solomon Islands, leaving the widespread *P. aristolochiae* in much of south and southeast Asia, including Sundaland, Sulawesi and the Philippines.

The centre of origin of the tribe Troidini remains unresolved. Braby *et al.* (2005) objected to the suggestion of a North American origin (Hancock 1983) on the grounds that it 'does not explain the absence of the Troidini in Europe and Africa'. However, such absence might merely reflect a lack of suitable host plants or habitat, either now or in the past, or the tribe's failure to disperse there. Within the Troidina the red abdominal hairs, shape of the juxta and loss of the appendix bursae suggest that the *Atrophaneura* group is more closely related to *Parides* + *Euryades* than to the *Troides* group and that the latter is the most primitive. If so, then *Battus* (subtribe Battina) likely is of South American origin, with subtribe Troidina evolving in eastern Gondwana and subsequently dispersing back to South America as the ancestor of *Parides* + *Euryades*. Any original North American ancestor, if such existed, presumably become extinct due to subsequent climatic changes (ice ages) and/or competition from reinvading *Battus*.

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REVIEW OF THE GENUS *DUNGOORUS* CARNE (COLEOPTERA: SCARABAEIDAE: RUTELINAE: ANOPLGNATHINI)

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Abstract

The genus *Dungoorus* Carne is reviewed and now contains two species: *D. murrumbullus* Carne and *D. frater* sp. n. An identification guide is given for the genus and both species, including descriptions, diagnoses and a key to species. Distributional data and a description of the female are presented for the first time.

Introduction

The ruteline beetle tribe Anoplognathini occurs only in Australia and the Neotropics. Phillip Carne last reviewed the Australian taxa in a series of papers published in the 1950s. In his main work on this group, Carne (1958) described many new taxa, including the monotypic genus *Dungoorus* Carne. He placed it in the subtribe Schizognathina and commented that it was similar to the genus *Saulostomus* Waterhouse. The description of *Dungoorus* and the new species *D. murrumbullus* Carne were both based on a single specimen without locality data [although Carne (1958) hypothesized that the specimen was collected in Queensland, based on other specimens he was familiar with bearing similar labels]. Since the original description, no new information has been published on this genus. Recently, I discovered further specimens in three collections. This paper reviews the genus *Dungoorus* based on these additional specimens and provides previously unknown information on this genus, including a description of females, reliable distributional data and the discovery of a new species.

Specimens were borrowed from and deposited in the following institutions (collections managers and/or curators listed in parenthesis). A total of 23 specimens formed the basis of this review. All specimens examined were labelled with a determination label or one of my red or yellow type labels. ABTS - Andrew B.T. Smith Collection, Ottawa, ON, Canada; ANIC - Australian National Insect Collection, CSIRO, Canberra, ACT (Tom Weir); CASC - California Academy of Sciences, San Francisco, CA, USA (David Kavanaugh, Roberta Brett); CMNC - Canadian Museum of Nature, Ottawa, ON, Canada (Robert Anderson, François Génier); QMBA - Queensland Museum, Brisbane, Qld (Geoff Monteith).

Genus *DUNGOORUS* Carne, 1958

(Figs 1-3)

Dungoorus Carne, 1958: 198, 218 [key to genera of Australian Rutelinae, original description]; Machatschke, 1965: 13, 47 [distribution, catalogue listing]; Machatschke, 1972: 297 [catalogue listing]; Cassis and Weir, 1992: 375 [catalogue listing]; Smith, 2003: 199 [checklist].

Type species. *Dungoorus murrumbullus* Carne, 1958, by original designation. Gender of genus: masculine.

Description. Length 11.7-14.8 mm, width 6.8-8.2 mm. Colour yellowish-brown. Body ovate, convex. *Head* (Fig 1-2): Dorsal surface moderately punctate on frons, densely punctate on clypeus; clypeus with erect, golden-brown setae. Clypeal apex strongly reflexed. Labrum reduced, apex without medial tooth or projection. Mandible plate-like, projecting well past apex of clypeus in dorsal view; apex and lateral margin strongly reflexed. Terminal maxillary palpomere in males greatly enlarged with elongate sulcus, approximately as long as antennal club. Terminal maxillary palpomere in females not greatly enlarged, much shorter than antennal club. Mentum constricted apically but not curved into oral cavity, without apical notch or tooth. Antenna with 9 antennomeres. *Pronotum*: Disc glabrous, moderately punctate. Marginal bead present laterally, absent medially on base and apex. *Elytron*: Surface glabrous; longitudinal striae poorly defined, densely punctate; without membranous border. Suture apically rounded, without acute spine or projection. *Pygidium*: Surface convex, smooth, setose apically; setae erect, golden brown. *Venter*: Thorax setose. Mesothoracic process not developed. Abdominal sternites sparsely setose. *Legs*: Protibia with 3 sharp, subequal teeth; apical spur absent. Tarsomeres 1-4 in males as wide or wider than long, cup-shaped. Protarsomere 1 in females long, approximately as long as protarsomeres 2-4. Protarsomeres 3-4 in males with weak internoapical stridulatory ridges. Protarsomere 5 in males with weak internomedial, stridulatory surface. Unguitractor plate laterally flattened with 2 setae. Modified tarsal claws in males thickened, elongate when compared with other claw, without teeth or bifurcations. Modified tarsal claws in females simple, not thickened or toothed.

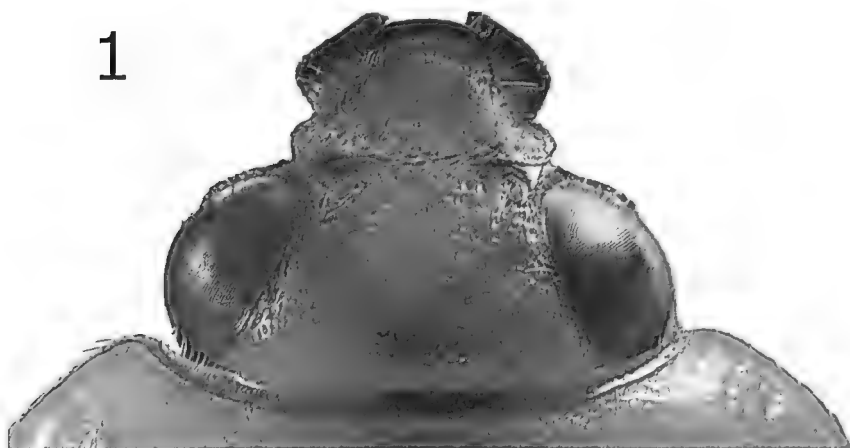
Male genitalia. Phallobase not fused with parameres. Parameres weakly fused, longitudinally contiguous.

Diagnosis. *Dungoorus* is distinguished from all other genera of Anoplognathini by the following combination of characters: labrum reduced, apex without medial tooth or projection; mandible plate-like, projecting well past apex of clypeus in dorsal view and with apex and lateral margin strongly reflexed; terminal maxillary palpomere in males greatly enlarged, approximately as long as antennal club; mentum flat, constricted apically but not curved into oral cavity; antenna with 9 antennomeres; clytron without membranous border, glabrous; mesothoracic process absent; protibia without spur; tarsomere 5 with simple claws; unguitractor plate with 2 setae; male genitalia with phallobase and parameres not fused; parameres with apices close together (not widely separated), not fused.

Distribution. Central and southern Northern Territory to southwestern Queensland, Australia (Fig. 3).

Key to species of *Dungoorus*

- 1 Frontoclypeal suture a well-defined, elevated ridge (Fig. 1); clypeal apex in males evenly rounded; mesotarsomere and metatarsomere 1-4 in males compact, as wide as long. Queensland *D. murrumbullus* Carne
- Frontoclypeal suture absent except at lateral margins (Fig. 2); clypeal apex in males bidentate, teeth at lateral edges; mesotarsomere and metatarsomere 1-4 in males strongly compact, wider than long. Northern Territory *D. frater* sp. n.



Figs 1-2. *Dungoorus* spp. (1) *Dungoorus murrumbullus* head and pronotum; (2) *Dungoorus frater* head and pronotum.

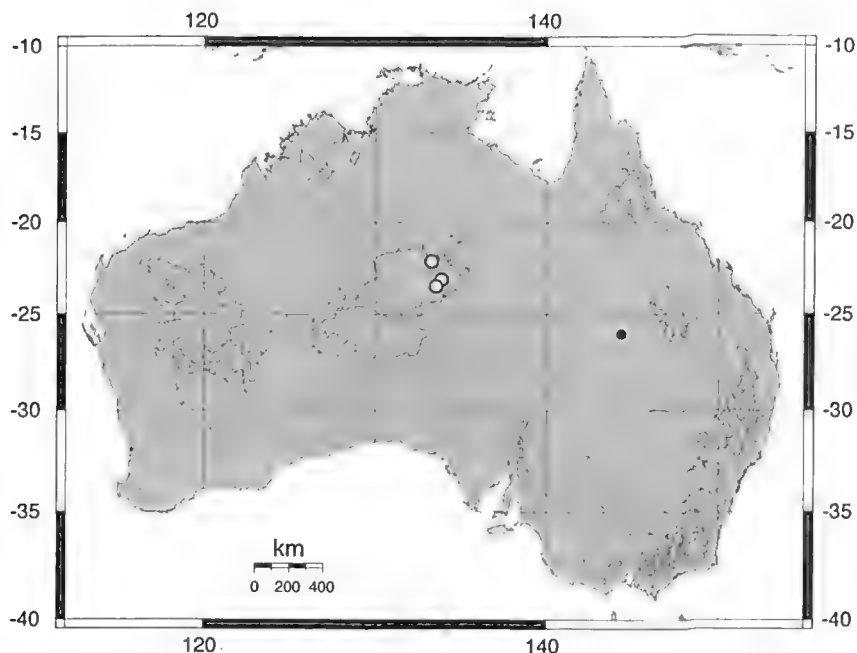


Fig. 3. Known distribution of *D. frater* (white circles) and *D. murrumbullus* (black circle).

***Dungoorus murrumbullus* Carne, 1958**

(Figs 1, 3)

Dungoorus murrumbullus Carne, 1958: 219 [original description]; Machatschke, 1965: 47 [catalogue listing]; Machatschke, 1972: 297 [catalogue listing]; Cassis and Weir, 1992: 375 [catalogue listing]; Smith, 2003: 199 [checklist].

Type material examined. *Holotype* ♂, labelled: (a) 'Type' (round label with red border, typeface); (b) 'Lea has not 13-12-18' (typeface and handwritten); (c) 'Not in coll. of S. Aus. Museum' (typeface); (d) 'QUEENSLAND MUSEUM' (pink label, typeface); (e) 'Prob. n. g. near *Saulostomus* Claws uneven Curious palpi' (handwritten); (f) 'Holotype of *Dungoorus murrumbullus*, sp.nov. P.B. Carne det., 1957' (handwritten and typeface); (g) 'DUNGOORUS MURRUMBULLUS CARNE, 1958 HOLOTYPE ♂' (red label, handwritten and typeface); (h) 'QM Reg. No. T.5533' (handwritten) [in QMBA]. Carne (1958) indicated that this species was described using a single specimen. He speculated that the specimen was collected in Queensland, based on the labels and his experience dealing with Queensland specimens examined by A.M. Lea. Type locality: Queensland, Australia.

Other material examined. QUEENSLAND: 1 ♂, Milroy (30 km N Quilpie; 26° 03'S, 144° 21'E) [in QMBA].

Diagnosis. Male ($n = 2$). Length 11.7-12.2 mm, width 6.8-7.5 mm. *Head:* Frons flat apically. Frontoclypeal suture complete, weakly elevated ridge. Clypeus concave, apex evenly rounded without lateral teeth. *Legs:* Tarsomeres 1-4 thickened, width approximately equal to length, cup-shaped.

Female unknown.

Distribution (Fig. 3). Southwestern Queensland, based on the holotype and one additional specimen in QMBA from Milroy, near Quilpie.

Temporal data. November (1).

***Dungoorus frater* sp. n.**

(Figs 2-3)

Types. *Holotype* ♂, NORTHERN TERRITORY: labelled 'Ti-Tree N.T. 30/12/1982 D.P. Carne At light' (handwritten) and 'Dungoorus murrumbullus Carne m det. T.A. Weir 1991' (handwritten and typeface) [in ANIC]. *Paratypes:* 2 ♀♀ [including allotype], same data as holotype except with 'f' instead of 'm' on the second label [in ANIC]; 12 ♂♂, 5 ♀♀, labelled 'AUSTRALIA: Northern Territory, 11 mi ne Yambah, nr Alice Springs, 625 m. 29 October 1962' (typeface) and 'Collectors: E.S. Ross D.Q. Cavagnaro' (typeface) [9 ♂♂, 2 ♀♀ in CASC; 1 ♂, 1 ♀ each in QMBA, CMNC and ABTS]; 1 ♂, labelled 'burrowing in soil below cattle dung CADNEY BORE 40 km NW ALICE SPRINGS 6-xii-1975 G. Griffin.' (handwritten), 'Dungoorus sp. DET. T. WEIR 1977' (handwritten and typeface), and 'Dungoorus murrumbullus Carne P.B. Carne det., 1977' (handwritten and typeface) [in ANIC]. Type locality: Ti Tree, Northern Territory, Australia (22° 08'S, 133° 16'E).

Description. Male [holotype]. Length 14.8 mm, width 8.1 mm. Colour yellowish-brown. Body ovate, convex. *Head:* Dorsal surface with depression from clypeus to apex of frons; depression setose with erect, golden-brown setae. Frontoclypeal suture absent except laterally. Clypeal apex strongly reflexed, bidentate with lateral teeth. Terminal maxillary palpomere greatly enlarged with elongate sulcus, approximately as long as antennal club. Terminal labial palpomere enlarged with elongate sulcus, less than half as long as terminal maxillary palpomere. *Pronotum:* Widest near apex; disc glabrous, moderately punctate. *Elytron:* Surface glabrous; longitudinal striae poorly defined, densely punctate; without membranous border. Suture apically rounded, without acute spine or projection. *Pygidium:* Surface convex, smooth, setose apically; setae erect, golden brown. *Legs:* Protibia with 3 subequal teeth. Mesotibia and metatibia robust, thickest medially and apically. Tarsomeres 2-4 greatly thickened, wider than long, cup-shaped. Protarsomeres 3-4 with weak internoapical stridulatory ridge. Protarsomere 5 with weak internomedial stridulatory surface. Modified tarsal claws thickened and elongate when compared with other claw, without teeth or bifurcations. *Male genitalia:* Phallobase slightly longer than length of paramere. Paramere with elevated apical and apicolateral margins; apex strongly deflexed.

Female [allotype]. Length 14.8 mm, width 8.2 mm. As holotype except in the following respects. *Head*: Clypeal apex strongly reflexed, evenly rounded without lateral teeth. Terminal maxillary palpomere not greatly enlarged, without sulcus. Terminal labial palpomere not enlarged, without sulcus. *Legs*: Tarsomeres 2-4 thickened, length approximately equal to width. Protarsomeres 3-4 and protarsomere 5 without stridulatory surfaces. Tarsal claws not modified or thickened; paired claws weakly asymmetrical.

Variation. Male (n = 13). Length 12.4-14.8 mm, width 7.4-8.2 mm. Female (n = 6). Length 12.8-14.8 mm, width 6.9-8.2 mm. The paratypes do not differ significantly from the holotype and allotype.

Etymology. *Frater* is the Latin word for brother and this species has a very similar gestalt to *D. murrumbullus*. According to Carne (1958), *Dungoorus* is derived from the aboriginal word meaning 'a stranger.' If the first species described in this genus is a stranger, then this second species must be that stranger's brother!

Distribution (Fig. 3). Known from the following localities in southern Northern Territory, Australia: Cadney Bore (40 km NW Alice Springs; 23° 29'S, 133° 31'E), Ti Tree (22° 08'S, 133° 16'E) and Yambah (17.6 km NE; 23° 07'S, 133° 49'E).

Temporal data. October (17), December (4).

Acknowledgements

I thank David Kavanaugh (CASC) and Tom Weir (ANIC) for the loan of specimens. I also greatly appreciate the encouragement and assistance of Geoff Monteith and Peter Allsopp in studying Australian scarabs. This publication was supported, in part, by an NSF/BS&I grant (DEB-0342189) and an NSERC-PDF award to the author.

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THE IDENTITY OF '*TRYPETA*' *NIGRICANS* WIEDEMANN (DIPTERA: TEPHRITIDAE: TEPHRITINAE)

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Abstract

Trypeta nigricans Wiedemann, described from an unknown locality, is confirmed as a species of *Metasphenisca* Hendel and the Indian species *Metasphenisca bifaria* (Munro) is placed as a new synonym of it.

Introduction

Trypeta nigricans Wiedemann was described from an unknown locality (Wiedemann 1830). Bezzi (1913) suggested it might belong in *Acidia* Robineau-Desvoidy or *Aciura* Robineau-Desvoidy. Hardy (1968) examined the types (in Naturhistorisches Museum, Vienna [NHMV]), provisionally referred it to the genus *Metasphenisca* Hendel and suggested a possible Afrotropical origin. This was followed by Norrbom *et al.* (1999). *Metasphenisca* is an Afrotropical-Oriental genus currently included in the tephritine tribe Tephrellini (Hancock 1990).

Through the kindness of Peter Schnal (NHMV), I have examined photographs of the lectotype female. Although both wings are damaged, sufficient remains to leave no doubt that *T. nigricans* is the same species as *Metasphenisca bifaria* (Munro), described from southern India (Munro 1947) and only known from there.

Metasphenisca nigricans (Wiedemann)

Trypeta nigricans Wiedemann, 1830: 509. (Unknown locality).

Isoconia bifaria Munro, 1947: 111. (Coimbatore, India). **Syn. n.**

Metaspheniscus ? *nigricans*: Hardy, 1968: 147.

Metasphenisca bifaria: Hancock, 1990: 45.

Comments. Since its original description, the name *Trypeta* [or *Metasphenisca*] *nigricans* appears to have been used only in a list of names (Bezzi 1913), a catalogue of types (Hardy 1968) and a catalogue of World names (Norrbom *et al.* 1999). No additional specimens have been referred to it and it was not mentioned in any recent regional study or catalogue for either the Indian (e.g. Kapoor 1993, Agarwal and Sueyoshi 2005) or Afrotropical (e.g. Cogan and Munro 1980, Hancock 1990, 1991) faunas, unlike the currently used name *M. bifaria*. However, the Rules of the International Commission on Zoological Nomenclature (ICZN 1999), regarding automatic departure from the Principle of Priority for unused names proposed prior to 1900, do not appear to be fully applicable, with insufficient useage of the name *M. bifaria*. Accordingly, *M. nigricans* (Wiedemann) is accepted here as the senior and valid name, with *M. bifaria* (Munro) placed as a new synonym.

The wing pattern of this species is distinctive (Munro 1947), particularly the size and orientation of the two elongate, posterior hyaline indentations. *Metasphenisca* species normally have 3 pairs of frontal setae but Hardy (1968) recorded 5 pairs in the types of *M. nigricans* and Munro (1947: fig. 12) showed 4 pairs in his illustration of the head of *M. bifaria*, suggesting that the number of frontal setae in this species is variable.

Distribution. Known only from southern India (Tamil Nadu).

Host plant. Pods of *Barleria* sp. (Acanthaceae) (Munro 1947).

Acknowledgements

I thank Peter Schnal (Naturhistorisches Museum, Vienna) and Bernhard Merz (Muséum d'Histoire Naturelle, Geneva) for their help in obtaining information on the type of *T. nigricans*.

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THE IMMATURE STAGES OF *CEPHRENES MOSELEYI* (BUTLER) (LEPIDOPTERA: HESPERIIDAE) FROM TORRES STRAIT, QUEENSLAND

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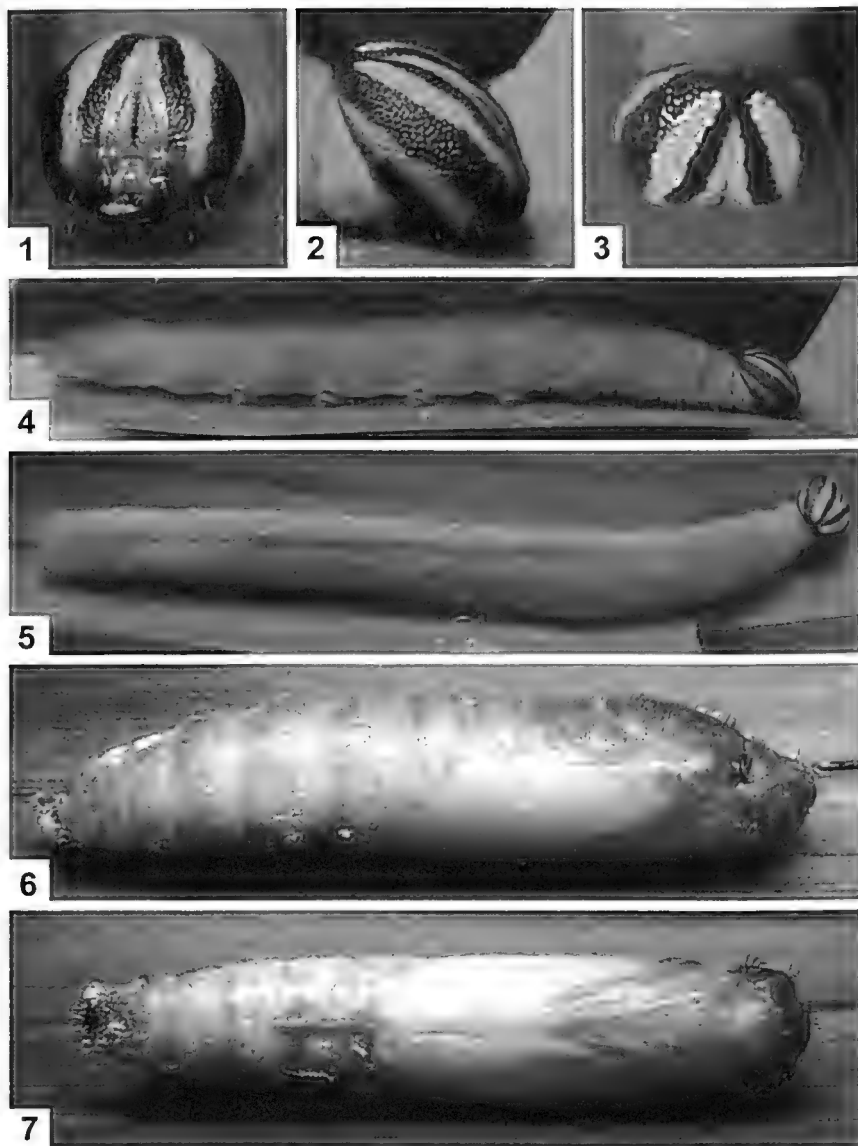
Abstract

The final instar larva and pupa of *Cephrenes moseleyi* (Butler) are described and illustrated from two specimens collected on Dauan Island, Torres Strait, Queensland and compared with the immature stages of *C. trichopepla* with which it occurs. Overall, on Dauan Island, larvae of *C. moseleyi* were encountered much less frequently than those of *C. trichopepla* (2:17). The host plant is *Cocos nucifera* Linnaeus (coconut palm), with juvenile palms found to be preferred by larvae of both *Cephrenes* species. The rearing of these two specimens from Dauan Island, together with another reared from Saibai Island in 2001, confirms the species' establishment in Australia.

Introduction

Cephrenes Waterhouse & Lyell is an Indo-Australian genus of skipper butterflies, with three species known from Australia (Braby 2000, Lambkin and Knight 2004). The larvae of the Australian species all feed on palms (Arecaceae) (Braby 2000, Lambkin and Knight 2004). Although predominately tropical, *C. trichopepla* (Lower) and *C. augiades* (C. Felder) are widespread along coastal Australia (Braby 2000), with *C. trichopepla* (Lower) also known from central Australia (Braby 2000). The invasion of these two species into new areas in recent years has been significantly aided by their accidental introductions on cultivated palms (Braby 2000). The third species, *C. moseleyi* (Butler) is known in Australia from only two islands in the northern sector of Torres Strait, Queensland (Lambkin and Knight 2004). Elsewhere, it occurs from the Moluccas, Aru and Kai Islands in Indonesia to New Britain and Bougainville, including mainland New Guinea and surrounding islands.

In Torres Strait, *Cephrenes trichopepla* occurs commonly, where it is known from almost all inhabited islands (unpublished data). In this region, larvae of *C. trichopepla* almost exclusively occur on *Cocos nucifera* Linnaeus (coconut palm). Oddly, despite its frequency in Torres Strait, Parsons (1998) found it uncommon on mainland New Guinea, but assumed that it was possibly widespread throughout much of the lowlands. Conversely, *C. augiades*, which in Torres Strait is only occasional locally and is much more rarely observed than *C. trichopepla*, is probably restricted to the islands in the lower half of the strait, namely Thursday, Prince of Wales, Moa and Badu (Mathew 1885, Waterhouse and Lyell 1914, Valentine and Johnson 1993, Braby 2000, collection records of A.I. Knight, T.A. Lambkin, C.G. Miller and G.B. Monteith).



Figs 1-7. *Cephrenes moseleyi* (Butler). (1-3) larval head capsule: (1) frontal view, width = 3.0 mm; (2) lateral view; (3) dorsal view. (4-5) final instar larva: (4) lateral view, length = 45 mm; (5) dorsal view, length = 43 mm. (6-7) pupa, length = 25 mm: (6) lateral view; (7) ventral view.

The life histories and larval hosts of *C. trichopepla* and *C. augiades* on the Australian mainland are well known (Dunn 1993, 1994, 1995, Lyons 1999, Braby 2000), including the final instar larval head capsule patterns, which are particularly diagnostic in identifying larvae of both species (Dunn 1993, Braby 2000). The mature larva and pupa of *C. moseleyi* were illustrated and briefly described by Parsons (1998), from material originating from Bulolo, Papua New Guinea.

During two field trips to Dauan Island, Torres Strait in 2004 and 2006, a number of *Cephrenes* larvae were collected from coconut and golden cane palms (*Dypsis lutescens* [H. Wendl.] H. Beentje & J. Dransfield) and reared to adults. The predominant species was found to be *C. trichopepla* (n = 17), with only two larvae of *C. moseleyi* collected. These two, together with a specimen reared from Saibai Island (Lambkin and Knight 2004), confirm its establishment in Australia. In this work, the final instar larva, head capsule and pupa of *C. moseleyi* are illustrated and described in detail for the first time from Australian material and compared with *C. trichopepla*.

Immature stages of *C. moseleyi*

Final instar larva (Figs 1-5). 43-45 mm long. Head capsule fawn in colour with a granulated surface and four conspicuous, reddish-brown to black vertical, almost parallel stripes consisting of a submedial and lateral stripe on each side of the head capsule joining at either side of the mandibles; frons with a short, centrally placed, thin brown vertical stripe immediately above mandibles. Body elongate, translucent, pale green to yellowish-green with a darker middorsal line extending from 4th abdominal segment to the anal plate; spiracles white, joined by a dull translucent white line; legs and prolegs, including bases, the same colour as body; anal plate granulated with prominent setae along its outer perimeter.

Pupa (Figs 6-7). 23-25 mm long; elongate and slender, variable in colour, pale yellow to yellowish-green; thorax and abdomen covered in short setae; wing cases pale with a distinctive brown enlarged thoracic spiracle at the base of each; a darker greenish-brown, trifid, projecting operculum covered with prominent setae; haustellum extending to 5th abdominal segment; tip of haustellum and antennae pale brown; cremaster rounded, with crenulate flange covered with posteriorly pointed spines.

Life history

The habits of the larva of *C. moseleyi* are similar to those of other *Cephrenes* spp. The larva constructs a silk-lined shelter on the host plant, in which it finally pupates. The surface of the pupa is covered in a light dusting of white, waxy powder. The three larvae of *C. moseleyi* encountered thus far in Australia, from Dauan and Saibai Islands (Lambkin and Knight 2004), were all collected from juvenile coconut palms growing in sand not far from the water's edge. In contrast, larvae of *C. trichopepla*, although found

exclusively on juvenile palms on Dauan, also occurred on coconut and golden cane palms away from the beach. Despite larvae of both species occurring on the same host species near the water's edge, it is not known whether they occur together on individual host plants. In general, adults of *C. moseleyi* were not often observed and, when observed, preferred to rest for long periods on or near their host plants (Lambkin and Knight 2004), as is the habit of the other two Australian *Cephrenes* spp (Dunn 1993, Lyons 1999). On Dauan, adults have also been collected from *Melaleuca* blossom.

Discussion

Final instar larvae of *C. moseleyi* and *C. trichopepla* closely resemble each other, but can be separated primarily by the different patterns on the head capsules. The pattern of vertical striping on the head capsule of *C. trichopepla* consists of two lateral black stripes, with two frontal black stripes running both sides of the frons, these stripes becoming laterally thicker just above the frons and thicker again closer to the mandibles. There is an orange-yellow patch on the cheeks either side of the mandibles at the base of the frontal stripes. Dunn (1993) provided very useful line drawings of the typical head pattern of both this species and *C. augiades*. The pattern of striping on the head capsule of *C. moseleyi* (Figs 1-3) is distinctly different from that of *C. trichopepla* and consists of two lateral and two frontal, almost parallel stripes which tend to be reddish-brown to black instead of the typical black stripes of *C. trichopepla*. There are no orange-yellow patches on the cheeks either side of the mandibles in *C. moseleyi*, with the two stripes either side of the head capsule joining at the base of the head. In addition, the ground colour of the head capsule of *C. moseleyi* is fawn while that of *C. trichopepla* is white. Larvae of *C. moseleyi* (Figs 4-5) are more elongate than those of *C. trichopepla*, are more yellow in colour and have the spiracles white rather than brown.

Pupae of the two species also differ. That of *C. moseleyi* (Figs 6-7) tends to be pale yellow to yellowish-green in colour, as opposed to the dirty-green to brown colour of *C. trichopepla*; it is also smoother in appearance than that of *C. trichopepla* and has a characteristic trifid, projecting operculum as opposed to the very dark, blunt and rounded operculum of *C. trichopepla*. The lengths of the haustella are also different (Parsons 1998), that of *C. moseleyi* extending to and just reaching the 5th abdominal segment while in *C. trichopepla* the haustellum reaches the 6th abdominal segment.

On Dauan, *C. moseleyi* is generally encountered less frequently than *C. trichopepla*. The collection of only two larvae of *C. moseleyi* during two field trips to Dauan, together with the paucity of adult Australian material known in collections (now about 10 specimens) attests to its overall rarity on Dauan and Saibai Islands. Parsons (1998) also reported the wide-ranging rarity of this species in Papua New Guinea but did indicate that it can be occasional locally.

Acknowledgements

I thank the Dauan Island community council for its cooperation during the periods of fieldwork spent on Dauan Island, and C.G. Miller and G.B. Monteith for providing collection records. J.S. Bartlett gave valuable assistance by preparing the colour plate.

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BOOK REVIEW

Dragonflies of Peninsular Malaysia and Singapore. A Pocket Guide, by A.G. Orr. Natural History Publications (Borneo), Kota Kinabalu. 2005; vi + 127 pp; soft covers; illustrated throughout. ISBN 983-812-103-7.

This pocket guide to the odonates of Peninsular Malaysia and Singapore is the first to cover this region and is ideally suited to its purpose. Attractively presented with colour paintings on every page, it will be useful to beginner and expert alike. Of the 230 species recorded, 98.7% are discussed and their adult males illustrated. Small differences between similar species are depicted clearly by additional illustrations, as well as by details of the male appendages where needed. A representative selection of larvae is shown in line drawings. Anyone familiar with the author's previous award-winning publication on the dragonflies of Borneo [see *Australian Entomologist* 31: 4 (2004)] will recognise the quality of his artwork, which in this instance renders the use of complex keys in the field superfluous.

The species accounts are necessarily brief but include details of size, distinguishing characters, habitat, general distribution and notes on behaviour and larvae. The book is a model of conciseness, including a general introduction, a checklist and a guide to further reading, in addition to the species accounts - all of which is encompassed within 127 pages.

It is interesting to note that there are only 88 species of Zygoptera recorded, against 141 of Anisoptera. This ratio is very different from the typical ratio in other countries, which is closer to 1:1. Could this be due to the large number (75 species) of libellulids - which include strong fliers and often migrants, or to the possibility that there are still a lot of Zygoptera out there awaiting discovery?

As a stimulus to the study of Malaysian and Singaporean species, this little book will surely encourage the discovery of more species and will be welcomed by all dragonfly enthusiasts. It could serve well as a model for similar treatments in other geographical regions and I, for one, would look forward to such an advance.

J.N. Yates

Imbil

A NEW SYNONYM AND A NEW COMBINATION IN THE FRUIT FLY TRIBE PLIOMELAENINI (DIPTERA: TEPHRITIDAE: TEPHRITINAE)

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Abstract

Pliomelaena udhampurensis Agarwal & Kapoor is placed as a new synonym of *P. spathulini forma* (Dirlbek & Dirlbek), comb. n. [transferred from *Metasphenisca* Hendel]. The species is known from NW India and NE Afghanistan.

Introduction

The fruit fly tribe Pliomelaenini contains several Indo-Australian species associated with the flowers of Acanthaceae. They were reviewed recently by Hancock (2004) but continued investigation has revealed a new synonym and a new combination within the group.

In addition, a second male of the little known species *Quadrिमelaena quadrimaculata* (Agarwal & Kapoor) has been located in The Natural History Museum, London. It is labelled 'India, W.W. Saunders' and 'prisca Walker', an apparent manuscript name. As expected, vein R₁ has a gap in the row of setae opposite the end of vein Sc.

Pliomelaena spathulini forma (Dirlbek & Dirlbek), comb. n.

Metasphenisca spathulini forma Dirlbek & Dirlbek, 1968: 175. (Darunta & Laghman, Nengrahar Province, NE Afghanistan).

Pliomelaena udhampurensis Agarwal & Kapoor, 1988: 119. (Udhampur, Jammu and Kashmir, NW India). **Syn. n.**

Comments. Although described in genus *Metasphenisca* Hendel (tribe Tephrellini), *P. spathulini forma* clearly belongs in genus *Pliomelaena* Bezzi in tribe Pliomelaenini. Descriptions and illustrations of both taxa listed above (Dirlbek and Dirlbek 1968, Agarwal and Kapoor 1988) leave no doubt that they are conspecific. This species is known from NE Afghanistan and NW India. For further discussion see Hancock (2004).

Acknowledgement

I thank Nigel Wyatt (NHM, London) for access to material in his care.

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BOOK REVIEW

The Smaller Majority: The Hidden World of the Animals that Dominate the Tropics, by Piotr Naskrecki. Harvard University Press, Cambridge, Massachusetts & London, UK. 2005; x + 278 pp; hardback. ISBN 0-674-01915-6. Price US\$35.

Invertebrates and other small animals play crucial roles in ecosystem health, including soil production, water filtration, pollination and provision of food for the other, larger vertebrates. In short, invertebrates make the Earth a liveable planet, yet insects and other invertebrates are disappearing from the globe at a rate faster than their larger vertebrate cousins, particularly in tropical regions. We do not know the precise rate of loss (nor for sure which species have gone), due to uncertainties in taxonomic composition and number and the general lack of baseline data on their distributions, but we can be fairly certain that the current extinction rate – the sixth (human-induced) mass extinction event – is faster than anything the planet has experienced in the past. The reason is simple: most tropical invertebrates have narrow, specialised niches, but the vast tropical forests of central West Africa, SE Asia and South America in which they live are disappearing at a phenomenal rate. Each species lost is another chapter of the genetic diversity and evolutionary history destroyed forever.

Moreover, most animals are small and live in tropical latitudes, yet most people do not notice small animals and live in temperate latitudes, compounding the problem. So what is the solution? A key first step is the need for better education and conservation advocacy, promoting the importance and popularity of invertebrates and the need to conserve the habitats in which they live. *The Smaller Majority* fills this critical need. The author, Piotr Naskrecki, is Director of the Invertebrate Discovery Initiative of Conservation International, and has provided a compelling tool to promote invertebrates and their urgent need for conservation. His message is simple. If the general public can understand and appreciate the beauty and ecological importance of invertebrates, they are more likely to care for them; and caring is the key to their long-term preservation.

The purpose of the book is therefore to celebrate everything that is small and misunderstood in the natural biological world – to understand and notice them, and to highlight the enormous diversity of life found right under our very feet. This ambitious goal is admirably achieved with the presentation of a comprehensive collection of more than 400 stunning photographs from the tropical areas of the world, particularly Central America and Africa but also Australia and, to a lesser extent, the Solomon Islands and Madagascar, augmented with an informative text. It thus covers insects and other terrestrial invertebrates, together with small amphibians and reptiles, which Naskrecki collectively refers to as the 'smaller majority'. Given that nearly all animals on Earth are small and largely 'unseen', there is clearly a limit to how much attention can be allocated to each group. As Naskrecki notes [on page 3] 'It does not pretend to be an exhaustive overview of tropical biota, and its taxonomic coverage is fragmentary. Each page provides only a glimpse into an animal's world rather than a comprehensive account of its life cycle'.

The book focuses on three major terrestrial ecosystems: humid forests, savannas and deserts. These three biomes are not treated equally, with 174 pages (72%) devoted to humid forests compared with 46 pages (19%) to savannas and 22 pages (9%) to

deserts: the bias in coverage reflects differences in species richness between each biome rather than their spatial representation on the globe. A prologue sets out how the author discovered the smaller majority, and why it is important to understand and conserve invertebrates. The three major biomes follow, which make up the bulk of the book, with attention given to threatening processes. Then follows an epilogue in which Naskrecki highlights the taxonomic impediment of invertebrates against the current biodiversity crises and the urgent need to document the Earth's biological heritage more effectively. The epilogue includes a series of images depicting several undescribed taxa but, more importantly, we are reminded of the thrill and adventure of discovering species new to Science. A short chapter on photographing the smaller majority provides useful practical tips on working in the rainforest and the basic equipment needed. A list of international organisations (almost all in USA) devoted to conservation, acknowledgements and a species index (including both common and scientific names) complete the work.

The photographs are masterpieces in their own right and many fill an entire page! Particularly stunning are the pictures of *Cholus cinctus* (a weevil from Costa Rica: p. 15), in flight, *Gasteracantha metallica* (a jewel spider from the Solomon Islands: p. 108), *Pseudatteria leopardina* (a diurnal leafroller moth from Costa Rica: p. 147), *Uroplatus phantasticus* (a Malagasy leaf-tailed gecko: p. 159), *Tympanophora uvarovi* (an Australian balloon-winged katydid: p. 193) and *Polyspilota aeruginosa* (an African savanna mantid: p. 222) against the sunset, to name just a few. There is also an evocative image of two workers of *Oecophylla smaragdina* (green tree-ant or weaver ant from Australia: p. 132) attending the larva of a lycaenid butterfly (scientific name not given but clearly *Hypolycaena phorbas*). Most, but not all terrestrial invertebrates mentioned are illustrated. There is a strong bias towards katydids and allied insects, although this is probably understandable given that the author is a world authority of the group.

The Smaller Majority is more than a compilation of first class natural history photographs. The superb images are interwoven with text that is lucid, detailed, scientifically accurate and easy to read. Naskrecki is one of those rare authors who can communicate effectively to both the scientific audience and the wider general public. He also writes with flair and passion. Thus, the illustrative material is augmented with a considerable amount of information on natural history, ecology and evolutionary principles, as well as personal anecdotes. For example, we learn that the evolutionary success of weevils, the largest family of all living organisms, is probably due to their mouthparts being able to exploit seeds and nuts of flowering plants and the co-diversification of these plants in the Late Cretaceous. We also learn about the unique and spectacular radiation of the Australian spur-throated grasshoppers (Cantatopinae), and that the pointillist art style of Aboriginal paintings may have had its origins based on the colour patterns displayed by Australian spotted pyrgomorph grasshoppers. On pages 86-87, Naskrecki recalls his discovery of cockroaches and moths feeding at night on the honeydew of plant-feeding fulgorids (Auchenorrhyncha) – a most unusual association in which the benefit to both parties is not entirely clear. I was delighted to see a section devoted to the 'heelwalkers' – Mantophasmatodea – the newly recognised insect order from Africa that previously were thought to have died out in the Miocene.

I found few weaknesses with this book. A glossary would have been a useful addition, as some of the terms used (e.g. co-existence, cryptic, diurnal, mutualism, mimicry,

parasite) require some basic knowledge or understanding of tertiary-level biology, although the author has attempted to qualify many of these terms in the text; for example: 'A butterfly pupa, also known as the chrysalis, looks like a beautiful sculpture' [p. 144]. The index is unworkable; for instance, all ant species are listed under 'ants' but not under Hymenoptera or Formicidae, but all moths and butterflies are listed under 'Lepidoptera'. As a result, it is difficult to trace entries; for example, there is no separate entry for *Oecophylla smaragdina* under 'O' or 'S', nor under 'H' for Hymenoptera, 'F' for Formicidae or 'W' for weaver ant, and there is no separate entry for *Eurema hecabe* under 'E' or 'H', or under 'S' for sulphur butterfly. As it stands, the index assumes the reader knows the correct systematic placement of these and all other taxa. This is an unreasonable assumption given the audience for which this book is intended.

Despite these very minor shortcomings, *The Smaller Majority* is a landmark publication bringing together superb natural history, macro-photography, biological science and conservation concerns: it serves to promote both the importance of insects and the conservation of tropical habitats in which they live. The wide scope and general knowledge that Naskrecki has brought together in a single work are truly breathtaking. If you love insects or close-up photography, or desire to learn more about those 'far off' tropical places, then this book is for you. It will especially appeal to youngsters or anyone with a fascination of our natural world. I am confident that Naskrecki's dream 'that the images in this book will reinforce a child's interest in the natural life of caterpillars or frogs, or perhaps they will awaken a long-forgotten fascination with small creatures in an older reader' will be fulfilled. I am also confident that it will inspire the next generation of invertebrate conservation biologists. In summary, this work is a must buy!

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BOOK REVIEW

Of Peaches and Maggots: The Story of Queensland Fruit Fly, by A.C. Courtice. Hillside Books, Marengo, NSW. 2006; 336 pp; softback. ISBN 0-9588239-0-1. Available from Hillside Books, 1187 Marengo Road, Marengo via Dorrigo, NSW 2453. Price A\$34.50 (including postage).

This is an entertaining book, easy to read and well researched. Intended for non-professionals, it nevertheless has a much wider appeal. It entwines a history of fruit fly outbreaks in Australia and elsewhere, from the 1880s onwards (in particular the Toowoomba outbreak of 1885), with the author's own efforts to understand why they happened. It breathes life (in a romanticised way) into the minds and actions of many of the early entomologists involved with fruit fly research or control, including the familiar names of Henry Tryon, Walter Froggatt and Hubert Jarvis. Some are criticised and others praised, but the difficulties all these early workers faced are ably documented. Along the way some myths are debunked – for example, the history of the 1853 'Kiama' fly, long held to be one of the earliest records of Queensland fruit fly (*Bactrocera tryoni*) south of northern New South Wales but with no actual specimens in existence, has more than one intriguing twist. Some of the underlying causes attributed to many of the early outbreaks [and to some even earlier plant diseases, such as that resulting in the Irish 'potato famine'] are entirely unexpected.

I found particularly enjoyable, and enlightening, the tales of Dagobert Daldorf in India and Walter Froggatt in Australia – both of which help shed light on the vexed and enigmatic question [see below] of Mediterranean fruit fly, or Medfly (*Ceratitis capitata*) in India. Equally enjoyable are the discussions of Medfly's first detection in London in 1822 and the Queensland-New South Wales 'banana wars'. Noteworthy, too, is the well founded assertion that Medfly was present in Sydney several years before the 1898 date normally quoted and well before the arrival of Queensland fruit fly, which subsequently displaced it. In fact there is much of interest in this book, not just for those interested or involved in the study of fruit fly outbreaks, past or present.

There are some minor factual errors and some of a more serious and unnecessary nature, the latter possibly related to the author's apparent disdain for professional entomologists working in government departments. *Bactrocera tryoni* and *B. neohumeralis* are certainly not members of the *B. dorsalis* complex, which is represented in Australia by *B. cacuminata*, *B. opiliae* and *B. endiandrae*. Despite its primary use of cultivated fruits in southern Queensland and New South Wales, *B. tryoni* has a very large number of native hosts in northern Queensland. The geneticist referred to on page 153 was from Hawaii, not New Zealand and *B. occipitalis* is not the only pest member of the *B. dorsalis* complex in the Philippines – it occurs alongside the very similar, but distinct, *B. philippinensis*. The suggestion that the eradication of *B. papayae* from northern Queensland was 'staged for the benefit of trading partners ... but could not possibly have succeeded' is little more than a conspiracy theory which, like others of its ilk, does not withstand scientific scrutiny. *B. papayae* was eradicated due to the determined efforts, in exceptionally difficult circumstances, of those actively involved and the effectiveness of the attractant methyl eugenol. *B. papayae* has also invaded Papua New Guinea, where it remains well established. Cue-lure is less effective and this might in part explain why *B. tryoni* has not been eradicated successfully from Lord Howe Island. Another of these

seeming 'conspiracy theories' concerns the status of *B. aquilonis* in Darwin, implying ulterior motives which did not, and do not, exist. '*Ceratitis dentipes* [now *Lenophila dentipes*] belongs in family Platystomatidae and does occur in New South Wales.

The question of Mediterranean fruit fly in India is problematical. It does not occur there now and almost certainly never did. The frequent assertion that the type specimen of *C. capitata* was collected by Daldorf personally 'along or off the coast of Bengal' is at odds with the specimen's label, which states 'in mari indico' [in Indian Ocean]. It is more likely that the specimen was presented to Daldorf by one of the Danish sea-captains plying the trade routes between Copenhagen [or East Africa] and Calcutta, many of whom, as a Royal representative, he would have known. However, the suggested collection date (between 1798 and 1802) is likely to be correct. Since then, the only specimens actually recorded from India are 4 females and a male from Pusa [an Agricultural Research Station in Bihar] dated 20.viii.[19]07 and 23.ix.[19]08 but with no indication of who collected them (Munro 1938). However, there are no reports of a Medfly outbreak in India in 1907-08 [or at any other time] and the 'Pusa' record is more likely to be of mislabelled reference specimens obtained from overseas. [This does happen: specimens of Medfly in the Suriname Department of Agriculture labelled 'Paramaribo' actually came from California (DLH, pers. obs. 1989)]. Bezzi (1913) noted that the only material in the Calcutta Museum at that time were 2 specimens from Australia presented by W.W. Froggatt [presumably in 1908, when he visited both Pusa and Calcutta]. This congruence of dates is telling and there can be little doubt that the 'Pusa' specimens were also gifts from Froggatt. No one took any notice of them until Munro received them from New Delhi. Bezzi (1909) did not refer to them, merely stating that *C. capitata* was 'recorded from India [based on the type], where apparently comparatively rare'. Neither Froggatt himself (1909) nor Senior-White (1924) made any mention of them and both doubted the occurrence of Medfly in the Oriental Region. The 3 females recorded by Munro (1938) as 'bred from peach' in August 1907 were most likely bred by Froggatt in Sydney where, at that time, Medfly was abundant.

Despite the above comments and criticisms, the overall conclusions reached regarding the history and causes of past fruit fly outbreaks and the species actually involved are both persuasive and plausible. Whether they withstand the test of time or not remains to be determined, but the journey there is nonetheless a fascinating read.

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